Taxonomy, distribution and conservation status of the mole rats (Rodentia: Spalacinae) in the Carpathian Basin

PhD Thesis

by

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1. INTRODUCTION

Eurasian blind mole rats are underground living rodents extremely adapted to subterranean life with far a more specialized body than the insectivorous mole's (Topachevskii 1969). They are one of the most endangered mammals of the Carpathian Basin (Báldi et al. 1995). The number of mole-rats in the area fell drastically in the last hundred years (Csorba 1998), but the exact reason for this is still unknown. The decrease in population size and the isolated small habitats contribute to making the populations of the Carpathian Basin so endangered. Effective conservation has not been realized until very recently, mainly driven by the lack of the required knowledge.

The taxonomic classification of the subfamily Spalacinae was a serious issue at the start of their investigation and this hasn't changed in recent times. Though the monograph of Lajos Méhely (1909) was decisive in the evolutionary approach of the mole-rat researches and later several Hungarian researchers studied the anatomy (Bodnár 1928a), taxonomy (Szunyoghy 1937) and ethology (Bodnár 1927, 1928b, Vásárhelyi 1929, Sterbetz 1960) of mole-rats as well, the row of researchers ended after the 60's, meaning that the Hungarian populations have been omitted from the taxonomic investigations conducted with modern methods (cytogenetics, molecular biology).

At the same time in the last decades the Eurasian blind mole rats are regarded as an evolutionary model for active speciation and adaptive radiation. The main reason for this is that even though their physical appearance does not vary much, they can be divided into about 70, notably different distinct so called forms in terms of chromosome numbers, DNA sequences, even behaviour. Nowadays more and more researchers share the viewpoint that these isolated geographical forms are different species.

At the beginning of my study the mole rats were arguably the most mysterious mammals of the Carpathian Basin. Both the number of existing populations, the geographical spread of the forms and the number of individuals in surviving populations was unknown, as well as the genetic difference between the existing forms. We had only slight knowledge on the living conditions, distribution and endangering factors and the real extent of endangerment of the mole rats.

In line with above my aims were the following:

- Define the number of mole-rat taxons in the Carpathian Basin
- Reveal the differences among the taxons using the widest approach possible (morphological, genetic, habitat demands)
- Define the systematic status of each taxon
- Define the geographical distribution of the taxons
- Reveal the reasons of the different taxons and distribution patterns in the Carpathian Basin
- Provide practical information for the conservation of mole rats (endangering factors, risk assessment)

2. APPLIED METHODS

Collecting and Sampling

I started the interceptions at the habitats already known at the start of the study. While mapping the distribution I also intercepted animals from further inland and also from the trans-border Carpathian Basin mole-rat populations, aiming to get tissue samples for genetic experiments. During the sampling we took blood and skin samples in the Budapest Zoo. The process was led by a veterinarian possessing experience in the treatment of wild animals. After the sampling we set the animals free in their own tunnel system. None of the intercepted animals were killed or harmed during the sampling process.

Kariological study

I used lymphocyte and fibroblast cultures to produce chromosome slides for the kariological studies. For both I followed –with minor modifications- the methods of Moorhead et al. 1960, Hsu & Kellogg 1960 and Fox & Zeiss 1961. Metaphase chromosome preparations were made according to standard cytogenetic techniques.

Mithocondrial DNA study

For the mtDNA studies, beside the samples collected during the fieldworks I used mole rat tissue samples from all over the Carpathian Basin preserved in ethanol in the Hungarian Natural History Museum. The studied samples covered the entire Carpathian Basin except

Transdanubia and Serem. I sequenced the 870 bp long part of the cyt b gene, which I used to compare the different mole rat populations.

Skull–morphology study

For the skull-morphology study, I used the collection of the Hungarian Natural History Museum. I compared 102 skulls belonging to the lesser blind mole rat superspecies (*Nannospalax* (superspecies *leucodon*)) from the Carpathian Basin. I was looking for differences between the skulls of the forms, which are clear enough to be identification keys.

Define the natural distribution of the forms

In order to reconstruct the natural distribution of mole rats in the Carpathian Basin I collected all available written data of the mole rats habitats. Besides that I also used the places where the specimens stored in the Hungarian Natural History Museum were collected and the locations of the newfound populations during my researches. In order to reveal the natural distribution of the forms I used 1) the taxonomical viewpoint in the contemporary monographs 2) the genetic research of the alcoholic specimens in the Hungarian Natural History Museum and 3) the genetic research of the existing populations.

Comparing the natural distribution with climate- and soil maps

To the mole-rat localities I've ordered the following climatic variables: the monthly and the half yearly average temperature, the yearly average temperature, the monthly and half yearly average rainfall; the average yearly sum of precipitation; the number of the summer-, warm-, winter-, frozen-, snowing- and snow-covered days and the rate of aridity. I've ordered to the localities the following soil measures: physical soil versatility, soil PH and proportion of limestone, stock of the organic materials, thickness of the topsoil, sloping gradient, water management of the soil and quality of clay minerals. Besides that I've analysed regarding all localities the type and subtype of the present soil.

To the multi-variable data analysis I've used the PAST (Paleontological Statistics) software (Hammer et al. 2001). I've done the cluster analysis with UPGMA method, using Euclid's distance or correlation coefficient at numerical variables and Hamming distance for nominal ones. Due to variables with different measures I've done central (correlation) main component analysis. Reveling whether the given groups have significant difference I've done ANOSIM analysis, and to define the variables responsible for differences I've used the SIMPER method.

Mapping the recent distribution

When preparing the map of current habitats I've walked all habitats of Hungary where previously there were any data or written evidence of finding mole-rats. Besides that I've also conducted the check of the Transylvanian Basin and the northern part of Vojvodina.

Risk assessment

Revealing the risk assessment of the mole-rats in Carpathian Basin I've used the IUCN criteria-system. The classification and characterization of the habitats and endangering factors as well as the usage of definitions happened on the basis of IUCN Habitats Classification Scheme 3.0 and on the IUCN Threats Classification Scheme 2.1. In the case of each population I created an inventory of the factors endangering their existence and subsistence.

3. NEW SCIENTIFIC RESULTS

- Both genra (*Spalax* and *Nannospalax*) of the Eurasian blind mole rats can be found in the Carpathian Basin
- The *Nannospalax* genus is presented in the Carpathian Basin by four kriologicaly identical forms belonging to the lesser blind mole rat superspecies (*Nannospalax* (superspecies *leucodon*))
- All of these forms are endemic in the area
- The four taxons, except the *transsylvanicus* and *hungaricus* differ in terms of skull morphology
- Based on the mtDNA investigations finished so far, there are significant differences between the forms, which can be corresponded to species and subspecies level.
- The distribution pattern of the forms is not explained by either the geographic relief of the landscape, nor the soil types.
- I found significant differences in the climate of the taxons' areas.
- It has been proven that each species has to be treated as a separate conservational unit as they significantly differ in terms of population size and the degree of endangerment.
- All the taxons of the the lesser blind mole rat superspecies (*Nannospalax* (superspecies *leucodon*)) living int he Carpathian Basin are endangered!

4. Conclusions

Based on the results of my research the fact has become clear that the Hungarian mole-rats cannot be handled as one species, as there are vast genetic differences between the populations. These results are raising the necessity of separation on species level. It has also become apparent that the Hungarian mole-rat species have habitats in the wider Carpathian Basin but not outside of that. The distribution pattern of the Carpathian Basin mole-rat species can be explained – out of the examined factors – only by the climatic variables so I consider the climate as a factor with a significant role during their speciation. Based on the results I revealed the endangerment level of the mole-rats in the area and come to the conclusion it's higher than previously expected. By their extinction one would not only loose peripheral population of a single species but more separate evolving individual species.

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